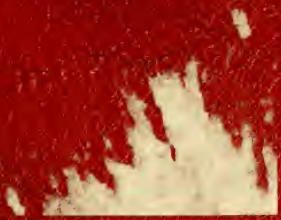

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MANAGEMENT USE OF MARKET ORIENTED MANAGEMENT INFORMATION SYSTEMS

ARNOLD E. AMSTUTZ

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ABSTRACT

This paper examines the impact of market oriented management information systems and managerial response to information technology. Two bases for change evaluation are proposed. The first focuses on the managerial process; the second on functions delegated to a computer-based system. The application of these measures is examined in the context of a particular market oriented information system.

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MANAGEMENT USE OF MARKET ORIENTED MANAGEMENT INFORMATION SYSTEMS

ARNOLD E. AMSTUTZ*

INTRODUCTION

This paper is concerned with the impact of market oriented management information systems in the management environment. Figure 1 presents a greatly simplified representation of this environment. There is a management group, a market to be influenced or managed, and competitors whose interests in the market may be incompatible with those of management.

If we are to assess an information system's impact on management interaction with the market, we must be able to describe the processes that link managers to the market. It would be particularly useful to have an accurate description of the ante-system management process -- an understanding of the nature of management interaction with the market in the absence of a system. Given a clear description of this process, it would be possible to assess changes in the manager's interaction with his environment associated with the introduction of the system.

It is, of course, meaningless to speak of a management process in which no system exists. Some form of systemization is present in any situation in which a management and an environment can be identified. It is,

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*Dr. Amstutz is Associate Professor of Management at the Massachusetts Institute of Technology and Chairman of the Board of Decision Technology, Incorporated.

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therefore, meaningless to look for simple shifts from a non-system to a system state. Meaningful analysis of realistically complex situations requires measures of varying levels of system support and of the changes in managerial activity.

It might be argued that the managerial process is a function of the market to be managed. I do not believe this is the case. The nature of the market clearly influences management action, measurement procedures, and the information used by management. It is, however, possible to abstract from the specifics of organizations and describe manager/market interaction in terms of a basic managerial process.

THE MANAGERIAL PROCESS

The functions to be performed by the manager may be described in many ways. I would suggest, however, that all managers engage more or less formally in the activities outlined in Figure 2. The extent, explicitness and formality of activity at each step may vary widely. However, to a greater or lesser degree, all managers perform these functions.

I believe that changes in the nature or extent of activity associated with each step may provide a basis for impact measurement. It is, however, premature to discuss this contention until we have examined the process described in Figure 2.

Description of the Process

If the manager is to operate effectively within his environment --

if he is to make decisions and take actions which create desirable change in the market -- he must understand that environment. He must be aware not only of what is happening, but also of why specific events occur. To consider taking action, the manager must have identified some characteristics of his environment -- answering the question, "What elements must be included if I am to represent this environment?"[1]

Once he has established a meaningful representation, he can begin to describe his assumptions about how the elements are related or interact. (Step 2) This process may be highly formalized with the creation of explicit models or limited to the qualitative consideration of a single relationship on the assumption that that interaction is controlling.

In the event that more or less formal consideration has been given to a set of alternatives, measures must be specified and used to test the validity of management's understanding (model) of the environment. (Step 3) If the tests suggest (Step 4) that the model originally formulated is incomplete, it may be necessary to expand the initial description to include previously ignored elements. (The arrow in Figure 2 shows a return to Step 1) If tests suggest that the originally formulated model is invalid, the model or measures may be revised and the tests repeated. Once an acceptable model is obtained, the measures are then used to determine current conditions in the environment. (Step 5)

If there is a discrepancy between measured and desired environmental conditions, management will then assess the value of changing environ-

mental conditions. The outcome of their considerations may establish an objective -- a desire to effect change in the market environment. (Step 6)

Given a decision to change the environment, management will consider the kind of action required to achieve their objective. (Step 7) Alternative plans are developed and expected market response determined. (Step 8) After evaluating the desirability and certainty of alternative plan outcomes, a single action is chosen. (Step 9)

After the selected action has been taken, (Step 10) market response is measured and evaluated against previously established objectives. (Step 11) If objectives have been achieved, no further action is required. If, however, objectives have not been realized, alternative action plans must be developed. As Figure 2 illustrates, management will return to Step 5.

I have suggested that the process outlined in Figure 2 will be found in any organization whether or not a computer or management information system is present. The major concern of this paper is, however, the impact of an information system that serves as an interface between management and the market environment. Figure 3 illustrates this relationship.

Potential Functions of Manager and Machine

Certain functions in the eleven step managerial process are uniquely suited to the manager while others may be equally well delegated to a machine. Steps 1, 2, and 3 involve description -- abstraction and pattern recognition. These steps are within the exclusive domain of the manager.

The computer can, however, contribute to model testing and may even perform limited evaluation using criteria provided by the manager. However, when a model is not valid, it is the manager who must determine the reasons for its invalidity and the ways to correct it.

On-going evaluation of conditions within the market environment (Step 5) may be delegated to the computer if management has specified measurement procedures, data processing requirements, reference standards, and methods of analysis.

If management's objective is to reduce the difference between existing and desired environmental conditions (Step 6), the computer can assist management by comparing conditions in the market against those desired by Management. Management must provide weightings to represent the value of reducing specified differences and/or the cost of deviating from the desired level. The system then uses these weightings to establish tradeoffs among various dimensions of change.

The system can also assist management in their development of alternative action plans (Step 7) if the managers have developed a model of the managerial decision process and linked it to their model of the market environment. Given both types of models and a linkage between them, the computer can identify certain management actions that appear to produce (are correlated with) desired changes in the market environment. Action alternatives may then be evaluated in terms of perceived action/result relationships.

The expected response of the environment to alternative actions (Step 8) may also be assessed by computer systems equipped to simulate probable environmental response processes. The models and system structure required to generate alternative action plans (Step 7) are more complex than those needed to evaluate expected conditional response to alternatives proposed by management and inputted to the system. (Step 8)

Once the conditional response to alternative actions has been determined, the choice process (Step 9) can be delegated to a system providing management is willing to exchange its traditionally subjective multidimensional analysis for explicit tradeoffs among the values, costs and uncertainties associated with attempts to achieve specified changes.

Those cases in which action can be taken (Step 10) through clerical processes (e.g. preparing a requisition, placing an order or establishing ad content) are easily delegated to the computer. Situations requiring greater flexibility or "creativity" (e.g. developing an ad layout) are not easily programmed. The distinction between choice (Step 9) and action (Step 10) is important. The former is more easily delegated to a computer than the latter.

Market response evaluation (Step 11) can be delegated to a system when management gains sufficient confidence in their environmental models. Given such models and inputs from the environment, a computer can determine whether a desired change in market conditions has been achieved. But what happens when the desired response is not achieved?

If failure is attributable to competitive actions or other conditions

measured by the system, evaluation may be made relatively systematic and, therefore, programmable. If measures received by the system conform to expectations or re-examination of response models is required. In this situation, previously noted problems of pattern recognition and structuring largely preclude computerization.[2]

MEASURING THE MANAGEMENT IMPACT OF SYSTEMS

Information system impact on management activity can be assessed through measures designed to evaluate change in:

1. The explicitness with which management attempts to describe the market environment,
2. The detail and validated reliability of models they use to represent behavior in the environment,
3. The manner in which measures are selected,
4. The allocation of management time among the eleven steps in Figure 2,
5. The nature of managerial response to market developments.

Management Description of the Market Environment

A major impact of information system development on management should be evident in an observable shift from implicit and vague descriptions to explicit, detailed representations. As managers gain experience verbalizing their assumptions about the market, there should be a noticeable

change from the use of relatively simple to more realistically complex representations.

Moreover, in the initial stages of system development, management's descriptions are generally static, snapshot-in-time representations. With experience, they become more aware of and concerned with processes occurring in the environment. A shift from static to dynamic representations should be observed.

Models Used to Represent Market Behavior

Management's initial models of market interactions and relationships are apt to be vague and to infer direct causality, e.g. advertising produces sales. One would expect information system development to motivate managers to develop more explicit, quantitative and complete representations of market interactions and relationships. We should see a shift in management's attempt to understand (and model) not merely what is happening in the market, but why it is happening. As a consequence, we should observe transitions from consideration of direct to indirect causality, from macro to micro models and from single coefficient to multiple factor structures.

Bases of Measurement Selection

A third measure of system development impact should be evident in the way management selects measures to assess market conditions. Initially, we should expect them to rely heavily on "available information." In the absence of a system-oriented structure, it is difficult to conceive of or implement new measures.

As management gains experience working with models they should begin to focus on interactions (processes) in the environment. Recognition of these processes should lead to attempts to measure what is happening.

In the early stages of system development, ease of measurement will be an important criterion of measurement selection. Management's objective will be to minimize risk by using measures that can be generated at a reasonably low cost. As management begins to recognize the value of meaningful information, they will be willing to risk increased expenditures to obtain more useful data.

Initially, management will want to measure factors directly linked to sales and profit, e.g. sales as an indicator of future revenue, or brand share as an indication of relative competitive advantage. As more time is spent evaluating alternative action plans, management will want to develop measures of market response to their actions. At this point, they will show greater concern for measures of behavior in the environment -- measures of generating rather than resultant processes.

Management Time Allocation

A fourth measure of information system impact relates to executive time allocation. As the manager begins to use an information system, he will place increased emphasis on selected activities within the Figure 2 sequence. Less time will be spent in routine analysis, evaluation and allocation (Steps 5, 8, and 11). As the procedures to be followed in these "programmable" activities are made increasingly explicit, authority over

them will be delegated to the computer-based system.

The first impact of an information system might be assessed by measuring the increase in the time managers devote to improving their understanding of the market and refining their insights about it. (Step 1) They should spend more time building models -- making explicit, testing, validating or rejecting hypotheses about the nature of their environment and their impact on it (Steps 2, 3, and 4).

As management begins to use the system, they should devote increased time to broader planning and policy issues associated with structuring and objective setting (Steps 1 - 4, 6, 7, and 9). They will perform these functions more effectively due to the availability of more meaningful data and increased (model-based) understanding of their market.

Managerial Response Patterns

The fifth measure of system impact focuses on the manager's performance of Steps 5 through 11. Information systems should enable the manager to adopt a broader perspective on his environment -- to become more aware of the processes he is attempting to influence as opposed to the results produced by these processes. As he becomes more aware of generating processes in the market, he will be better able to anticipate opportunities and problems.

The primary indicators of this change lie in two areas. The first is associated with Steps 5 through 8 and 11. The manager should adopt a

more proactive as opposed to reactive style. We should expect him to take action based on an analysis of market processes rather than reacting to symptomatic results of processes that have already occurred. As he becomes more aware of the conditional nature of his forecasts. We should expect to see increased contingency planning. The single plan of action will be replaced by a set of contingent plans keyed to economic, market, or product developments.

Another indicator of change is associated with Step 11. A well-designed information system will free the manager from many of his present day, routine commitments and provide the time and support needed to study the implications of new concepts and approaches. The manager should, therefore, have a new freedom to experiment with creative ideas and to employ imaginative approaches to the formulation and implementation of more effective marketing actions.

MEASURES OF MANAGER-SYSTEM INTERACTION

I have previously suggested that while no two managements and hence no two management-system interactions are the same, it is possible to describe alternative types of manager-machine interaction along the following five dimensions.[3]

1. Information recency -- the time lapse between occurrence of an event in the environment and inclusion of data describing that event in the system.
2. Information aggregation -- the level of detail

at which information is maintained by the system.

3. Analytic sophistication -- the completeness or complexity of the system's models and data structures.

4. System authority -- the level of authority management delegates to the system.

5. Management access -- the time lapse between a request for information and receipt of the desired report or display.

Dimensions 3 and 4 are particularly applicable in the context of this discussion. Figure 4 illustrates the relationship between these two dimensions. As shown, management is more willing to delegate authority to sophisticated systems and, conversely, as management places greater demands on an information system, a greater level of analytic sophistication is required.

System Sophistication

As Figure 4 indicates, the lowest level of analytic sophistication is that required to locate and retrieve information from a particular file. At the aggregation level, the system combines information from several records to produce a total or subtotal.

Given the sophistication required for arithmetic processing, the system can develop averages, compute differences, and relate entries from various parts of its data base. At the next level of sophistication, logical analysis, the system aggregates data in subsets or segments.

At the fifth level, the system uses statistical procedures to extrapolate from historic data, develop statistical estimates and perform analyses of variance or trend estimates.

In moving to the above point on the analytic sophistication dimension, we have been concerned with system capability to structure and evaluate data at or through a point in time. At the sixth level, the manager becomes concerned with the process generating data rather than the data per se. Macro process models may be used to relate multiple factors in the decision environment to current or expected conditions, and to examine dynamic relationships over time. Given this level of sophistication, the system contains information generated by the model and data derived through measures of real world activity.

The distinction between macro process models and micro analytic behavioral models is largely a matter of perspective. Macro process models provide a broadbrush description of relationships among major states in the environment. Micro behavioral models attempt to duplicate the interactions that generate those states.[4]

Micro behavioral models may be combined in a simulation structure to produce an artificial world in which management can test proposed policies and strategies.

The seven levels of system sophistication considered thus far permit a system to structure and analyze data and the relationships among data using specified procedures. It is, however, possible to develop systems

that have the capability to modify the procedures they are following -- to "adapt" to conditions met in the environment. At this highest level of system sophistication, the computer evaluates alternative parameter settings for model structures against data from the environment. Using various "adaptive heuristics" the system attempts to learn from experience -- to improve future procedures on the basis of experience gained using earlier ones.

System Authority

At the lowest level of system authority, management may delegate to the system the authority to retrieve information from specified records and files. Once a retrieval capability has been established, management may quickly conclude that while the computer is "looking at" each record's contents, it might check the content to insure against clerical errors.

As management comes to accept system review for purposes of error detection, it is quite natural to suggest that the computer perform additional analyses on records being reviewed and to refer for further review and action situations meeting criteria established by management. Thus, a monitor function is delegated to the system.

Management frequently finds that certain classes of monitor output are consistently subjected to additional analyses to determine whether action is warranted. In such situations, the computer can be programmed to perform additional calculations and to add a recommendation for action to the monitor report.

As management gains experience with computer-based recommendations, they may find that generally the system's recommendations can be implemented without further investigation. Criteria may be modified to isolate nontypical cases requiring additional review. The system is then given authority to take action on the remaining cases.

The heararchy of Figure 4 suggests that delegating authority to predict involves a higher level of management trust in the computer than delegating authority to act. While the models on which the system bases its action normally involve prediction, the potential impact of computer-based prediction is often greater than computer action. Erroneous computer actions may adversely affect the firm's position at a point in time. However, actions relate to the operating sphere while predictions are the basis for planning. Thus, inaccurate prediction may have a damaging effect on the firm's activities for months or years while erroneous actions can be corrected in days or weeks.

The chance for successful computer-based prediction is ironically reduced by the nature of managemen-computer interaction. Since predictions are often based on relatively sophisticated models, management frequently hesitates to accept computer prognostication until they have had an opportunity to "see how well it does."

However, as time passes, the modeled environment may change -- the original models may become less applicable. Finally, when management is ready to take action based on the computer's predictions, the models may

be outdated and inaccurately represent the decision environment. It is such considerations that argue strongly for heavy management commitment to Steps 1 through 4 of the managerial process. Such involvement insures that management understands the models on which system decisions and predictions are based.

If management acquires sufficient confidence in particular heuristics designed to adapt system models to changing environmental conditions, they may permit the system to modify selected parameters without prior management approval. Implementation of such adaptive procedures clearly magnifies the problems noted for prediction. Management is required to understand the implications not only of the operating decision models but also of the adaptive procedures used to modify the operating system.[5]

TWO PERSPECTIVES ON THE MEASUREMENT OF IMPACT

The structures summarized in Figures 2 and 4 offer two rather different ways of viewing the management process. The first is concerned with steps in the managerial decision making activity; the second with the functions performed by the manager and by the system. Either structure may be used to evaluate system impact or managerial response. The structure summarized in Figure 2 offers a useful framework for examining impact in terms of change in the nature or extent of management activity. The dimensions in Figure 4 provide an effective framework for examining the functions performed by manager and machine.

An Example of System Impact

The use of the impact measures, summarized in Figures 2 and 4, will be illustrated with an example of system development activity with which the author has been concerned since 1960.[6]

Figure 5 illustrates the management information system structure being used by this organization in 1970. Ten years earlier, when system development first began, the major objective was to provide a relatively simple market monitor capability. The initial system was designed to review all activity in a particular market and to bring actionable situations to the attention of the market research staff -- to support management activity associated with Step 5.

System development began with the formulation of a behavioral model of the market process. Steps 1 through 4 in Figure 2 occupied a major portion of management time between 1959 and 1963. During this period, functions associated with Steps 5 through 11 were performed with the aid of then existing systems. As models were expanded and refined, measures from the market and from other organizations of interest to management were entered in a data file.

By 1964, procedures for monitoring activity in the market had been validated. These procedures were incorporated in a system and used along with the model of market behavior and data from the environment to isolate situations where actions might profitably be taken. The market research staff would then investigate these situations in more detail and develop

recommendations for management action. The system's major contribution at this stage was to support Steps 5 and 6 of the managerial process.

With the initial research support system in operation, some managers began to consider ways in which the system could support higher level management activities. For example, they were interested in whether the system might be expanded to support Steps 8 and 9 -- evaluate alternative opportunities and problems using criteria provided by the manager.

To assess the potential contribution of alternative system support functions, the system was expanded to enable management to use the market process model to "simulate" the results that would be achieved using alternative management strategies. "Market Sim." in Figure 5 refers to this capability. The expanded system was used to ask the computer, "What would happen if . . ." a particular strategy were used under specified market conditions? The system then determined the performance that would have been realized in a particular historic market or hypothetical market type.

When using this system capability, management was again devoting substantial time to the first four steps of the managerial process. As a result, they discovered that their understanding of the basis of past actions left much to be desired. When alledged historic strategies were made explicit and implemented in the simulated environment, major differences between actual and simulated developments were detected.

The focus of model building (Steps 1 - 4) thus shifted from the market to management. To support the new activity, the system was further

expanded to incorporate a model of management decision procedures associated with Steps 7, 8 and 9. (See Figure 5, "Mgt. Process Sim.") It was now possible to ask the computer, "If we managed using these data, analyses, values and decision procedures, what would happen?" As the simulated manager took action in the simulated market, a wide range of management decision rules were evaluated and a set of procedures were selected for operating use.

During 1967 and 1968, the computer system was expanded to incorporate programs based on these procedures. Using these programs, the system performs Steps 5 through 9 of managerial activity and recommends action to management. Actions taken by management are reported to the system which maintains performance and accounting records. This final capability is represented in Figure 5 by "Decision System."

The evolution of this system has taken ten years. It began with a simple capability to support market research and moved through increasing stages of complexity to encompass models of management and market behavior. Today, the system monitors the markets in which the organization operates, selects actionable situations subject to management constraints, evaluates alternatives, and recommends actions.

Evaluation Using Measures of Management Activity Change

The system described in the example has produced change along each of the proposed managerial activity dimensions.

Management Representation of the Environment. System development began with an explicit description of the market environment. Management's implicit models were made explicit and tested. Initially simple formulations were refined and expanded until a reasonable complete representation of activity in that environment had been produced and verified.

Models Used to Represent Behavior. During the course of system development, changes in model structure and scope could be clearly identified. Initial models of the market were reasonably static -- focusing on conditions at a particular point in time. As the structure expanded to encompass management activity, dynamic process representations and feedback loops replaced earlier "open loop" system constructs.

Initial models of the management process were not only curde but inaccurate. Particularly dramatic changes occurred as management used the system to gain clearer perspective on current practices and desired modes of operation.

Bases of Measurement Selection. During the course of model development, change occurred from the use of available data to a recognition of the need for response related measures. The development of management decision process measures followed a similar pattern. Initial assessment was based on data traditionally maintained for reporting purposes. As the need for new measures became evident, major concern was expressed over the cost of maintaining required data. Major difficulties were encountered in establishing "objective" measures of management performance. The implied associa-

tion between measurement and evaluation made managers hesitant to provide descriptive information for fear that they might not meet subsequent evaluative standards.

Management Time Allocation. Noted changes in management time allocation should be evident from the preceding description. An initial emphasis on structuring, model building, testing and evaluation (Steps 1 through 4) was clearly evident. Later emphasis on other steps was associated with particular stages of system development and use over the ten year period. These transitions were gradual. There were no instantaneous changes. In addition, not all members of management exhibited change. The noted transitions were most evident in the behavior of those working closely with the system and using it to support their decision making.

Managerial Response Patterns. Measures of management perspective taken during the period of system development would have revealed significant shifts from event to process focus as well as the expected changes in action orientation. Comparisons of the organization between 1960 and 1970 provide dramatic evidence of changed behavior. It would have been difficult to detect change from quarter to quarter or even from year to year during that period. It is inappropriate to attribute all change to the system. Other developments within the organization and the market environment undoubtedly influenced management perspective and style.

Evaluation Using Measures of Manager-System Interaction

System Authority. Transition along the system authority dimension

in Figure 4 should be evident from the preceding discussion. The initial system encompassed retrieval and monitor functions. After ten years of development, management has given the system authority to take direct action in certain situations.

The managers have used the system to learn about their environment and their own behavior. However, the system specific learning activity, shown in Figure 4, is not present. The system establishes parameters for existing model structures on the basis of information obtained from the environment. It does not, however, have the authority to modify model structures or decision procedures.

System Sophistication. A parallel progression along the analytic sophistication dimension was also observed. Changes in analytic sophistication required to support increasing levels of system authority followed a relationship comparable to that illustrated in Fugure 4.

SUMMARY

This paper has considered the impact of management information systems and management response to information technology. It has suggested that impact can be measured in terms of either change in managerial perspective and activities, or change in authority delegated to a system. Both classes of change have been illustrated through an example based on one organization's experience.

The major issues involved in this consideration are human rather

than technological. And yet all too often discussions of this topic focus on computer hardware and software capabilities all but ignoring the fundamental management process that information technology must support if it is to contribute to managerial effectiveness and efficiency.

Our knowledge of existing, let alone normative, market and managerial processes is scandalously small.

The first priority of those concerned with the development and implementation of market oriented information systems must be, therefore, to develop an accurate description of market and managerial processes. Such a description can provide a framework through which meaningful measures can be generated and used to assess the current state of these processes. Until existing processes are understood, it is futile to discuss lofty states that might be achieved.

The success of future information system development will be largely determined by the willingness of manager and academician to stop playing with computers and begin the difficult task of understanding market and managerial processes. Whatever changes may occur will be gradual. Transitions from chaos to ordered simplicity will not occur in days, months, or even years. While the potential of the technology may be great, its application will be agonizingly slow. It is a relatively simple matter to program a computer. It is much more difficult to change managerial behavior.

FOOTNOTES

1. Formal requirements for environmental specification as well as the role of an explicit management-oriented environmental description in system development are discussed in A. E. Amstutz, "Shaping the Management Environment," Computer Operations, March-April, 1969, 44-50.

2. A highly readable discussion of programmable and nonprogrammable decision processes is provided in Herbert A. Simon, The Shape of Automation for Men and Management, New York: Harper & Row, 1965, 53-111.

3. For a detailed discussion the five dimensions, see A. E. Amstutz, "The Evolution of Management Information Systems," European Business, July, 1968, 24-33.

4. An excellent example of macro process modeling is provided by R. S. Weinberg, "Multiple Factor Break-Even Analysis," Operations Research, April, 1956, 152-186. Micro analytic behavioral modeling is discussed in A. E. Amstutz, Computer Simulation of Competitive Market Response. Cambridge, Mass.: The M.I.T. Press, 1967.

5. An example of a relatively simple adaptive system structure is provided in P. R. Winters, "Forecasting Sales by Exponentially Weighted Moving Averages," Management Science, April, 1960, 324-42.

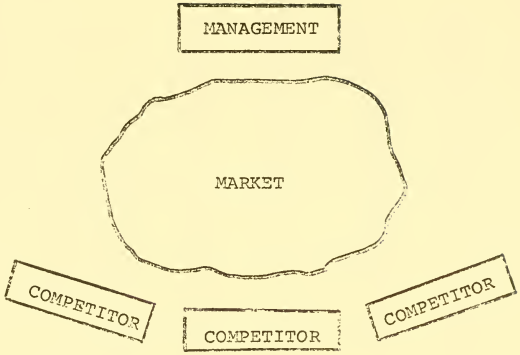
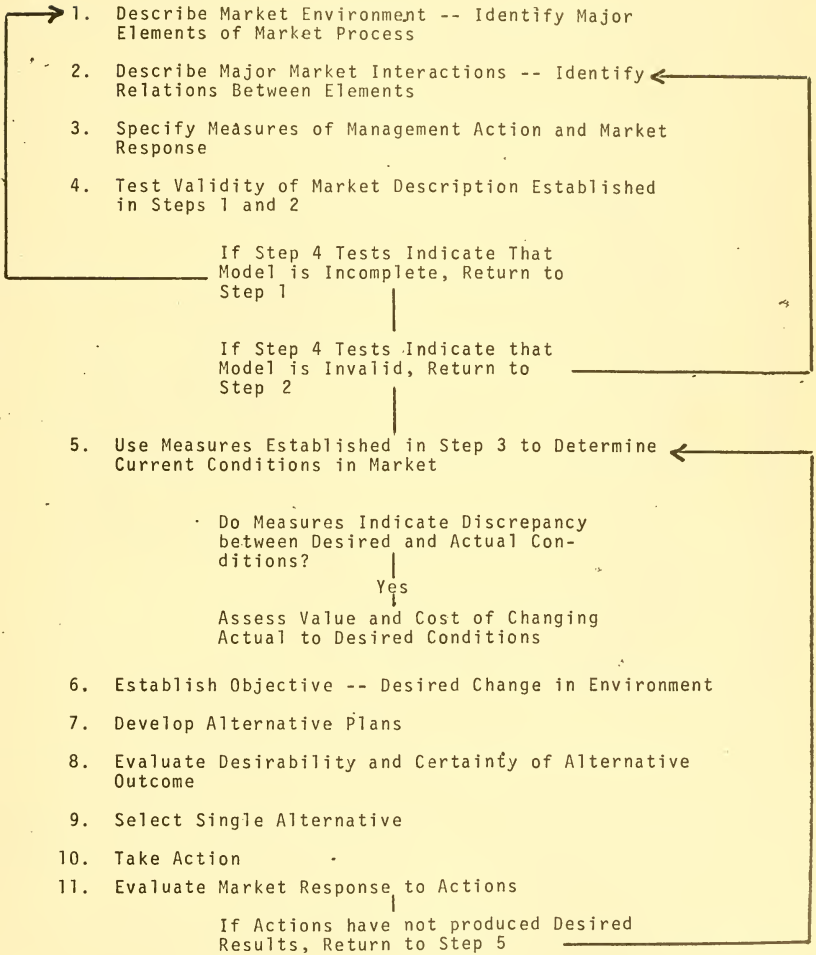


FIGURE 1 - THE SYSTEM ENVIRONMENT

Figure 2

Information-oriented Steps in the Managerial Process


1. Describe Market Environment -- Identify Major Elements of Market Process
2. Describe Major Market Interactions -- Identify Relations Between Elements
3. Specify Measures of Management Action and Market Response
4. Test Validity of Market Description Established in Steps 1 and 2
If Step 4 Tests Indicate That Model is Incomplete, Return to Step 1
If Step 4 Tests Indicate that Model is Invalid, Return to Step 2
5. Use Measures Established in Step 3 to Determine Current Conditions in Market
Do Measures Indicate Discrepancy between Desired and Actual Conditions?
Yes
Assess Value and Cost of Changing Actual to Desired Conditions
6. Establish Objective -- Desired Change in Environment
7. Develop Alternative Plans
8. Evaluate Desirability and Certainty of Alternative Outcome
9. Select Single Alternative
10. Take Action
11. Evaluate Market Response to Actions
If Actions have not produced Desired Results, Return to Step 5

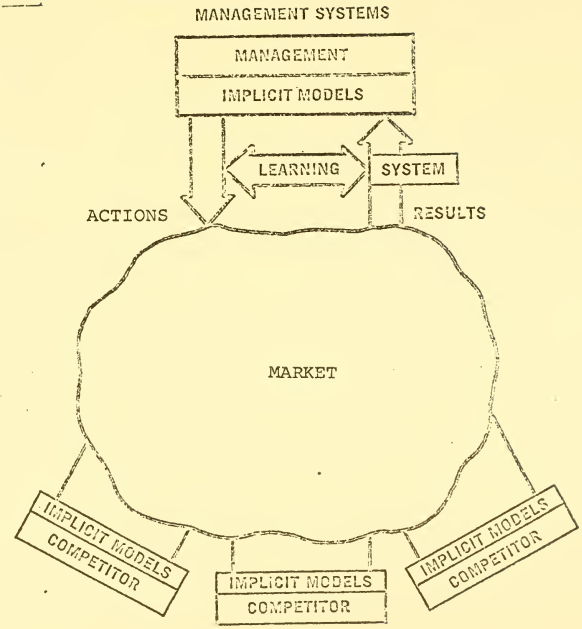
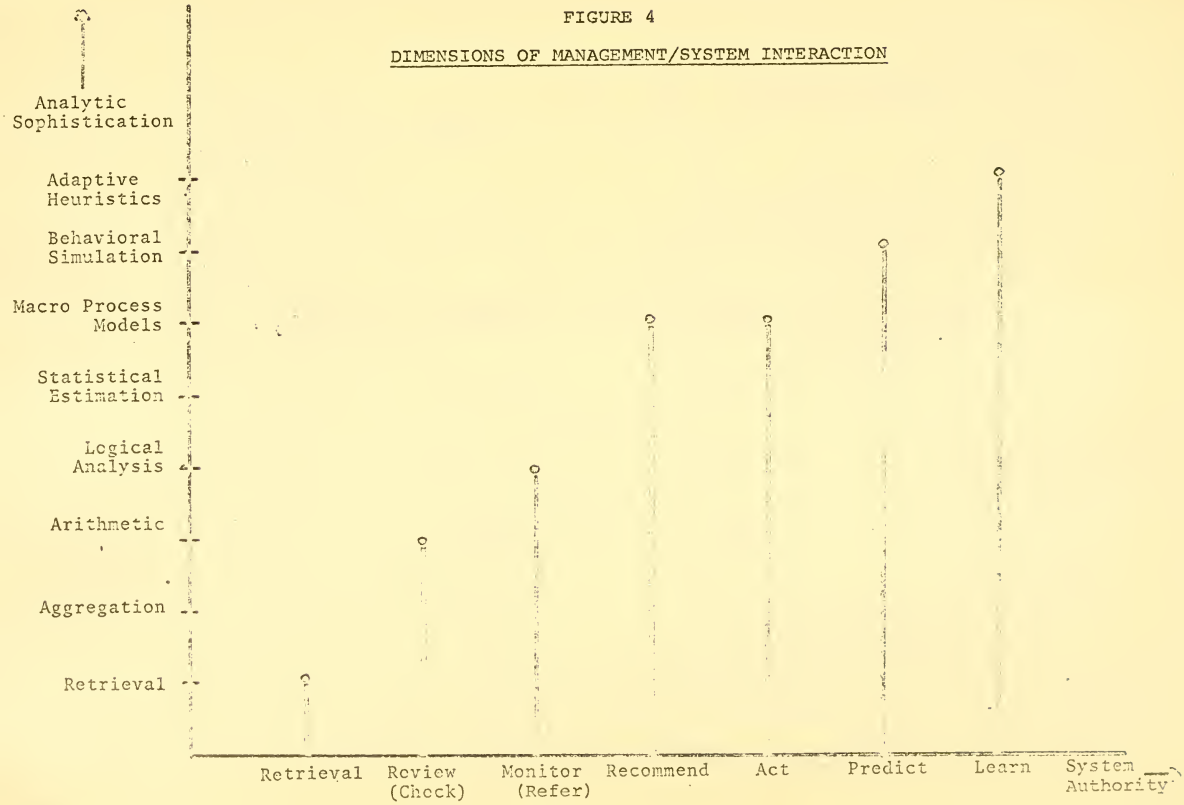


FIGURE 3 - THE MANAGEMENT/MARKET INTERFACE

FIGURE 4

DIMENSIONS OF MANAGEMENT/SYSTEM INTERACTION



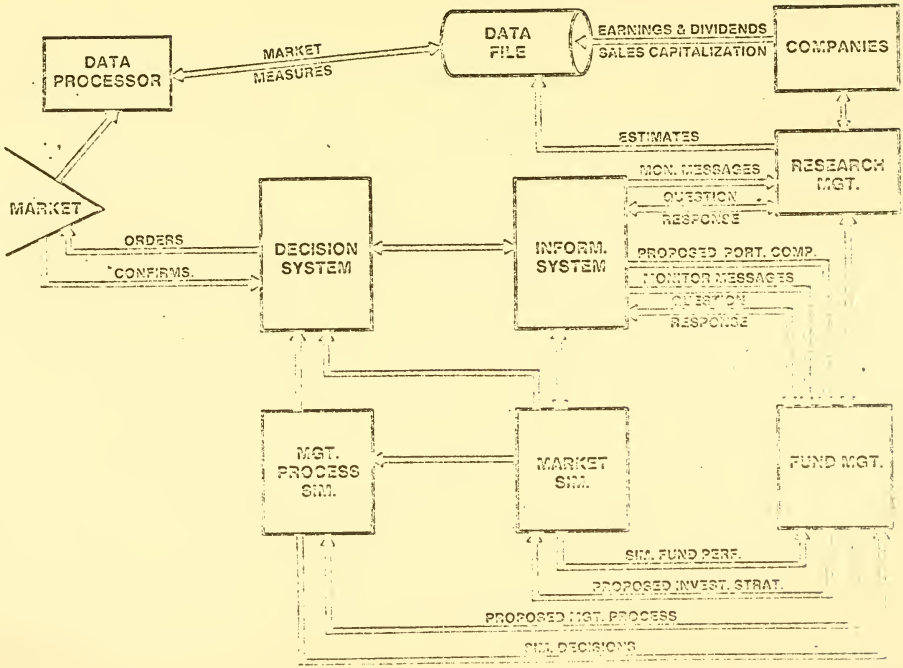


FIGURE 5 - AN EXAMPLE OF INFORMATION SYSTEM STRUCTURE

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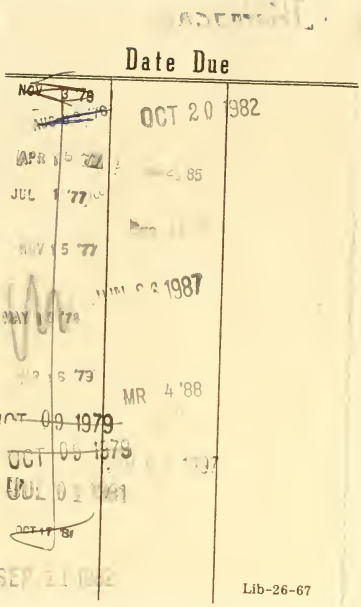
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